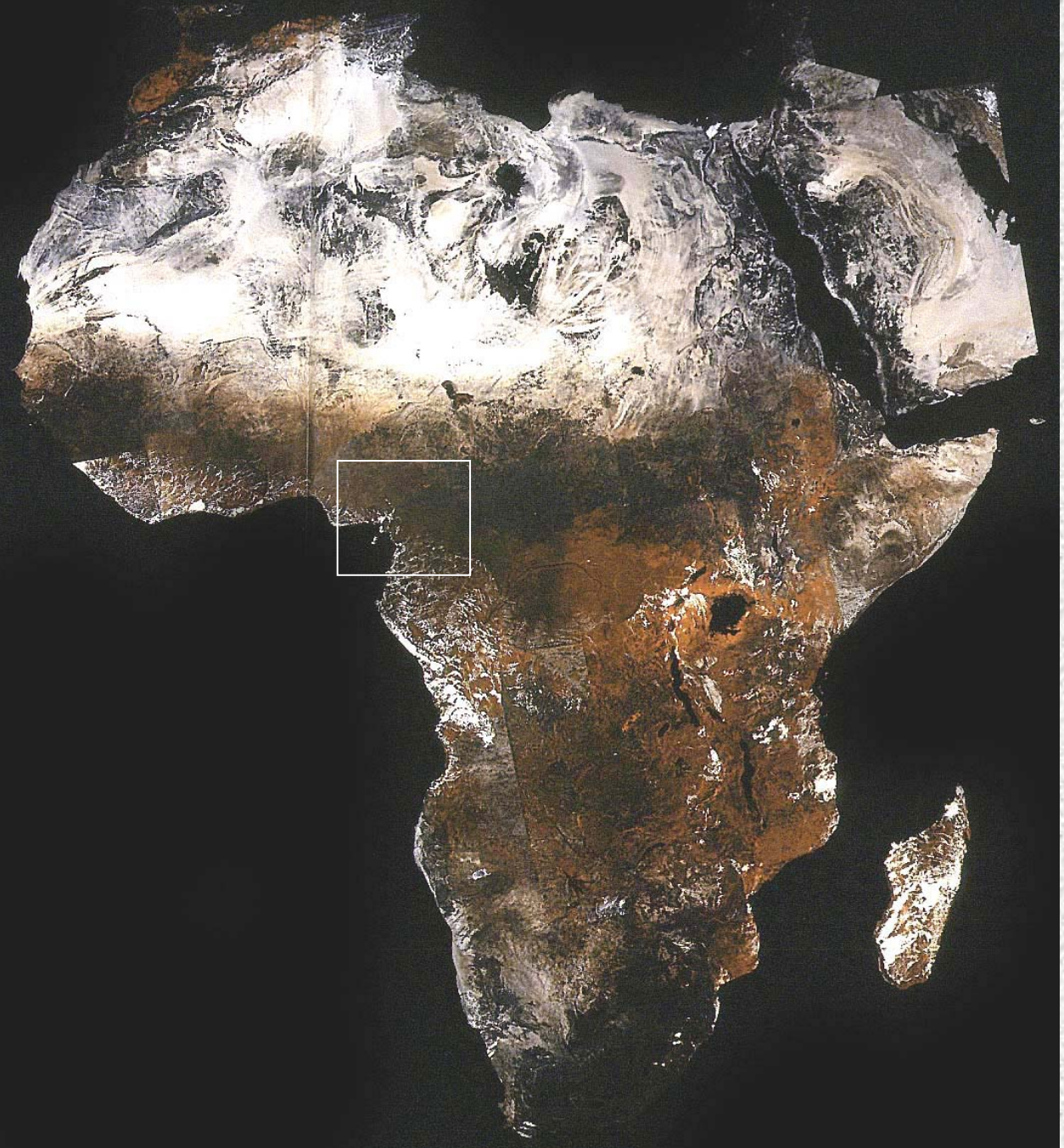

Thanks to Dr. George Kling, Univ. of Colorado

Killer Lakes:
The Lake Nyos Gas Disaster

Scientific Team:

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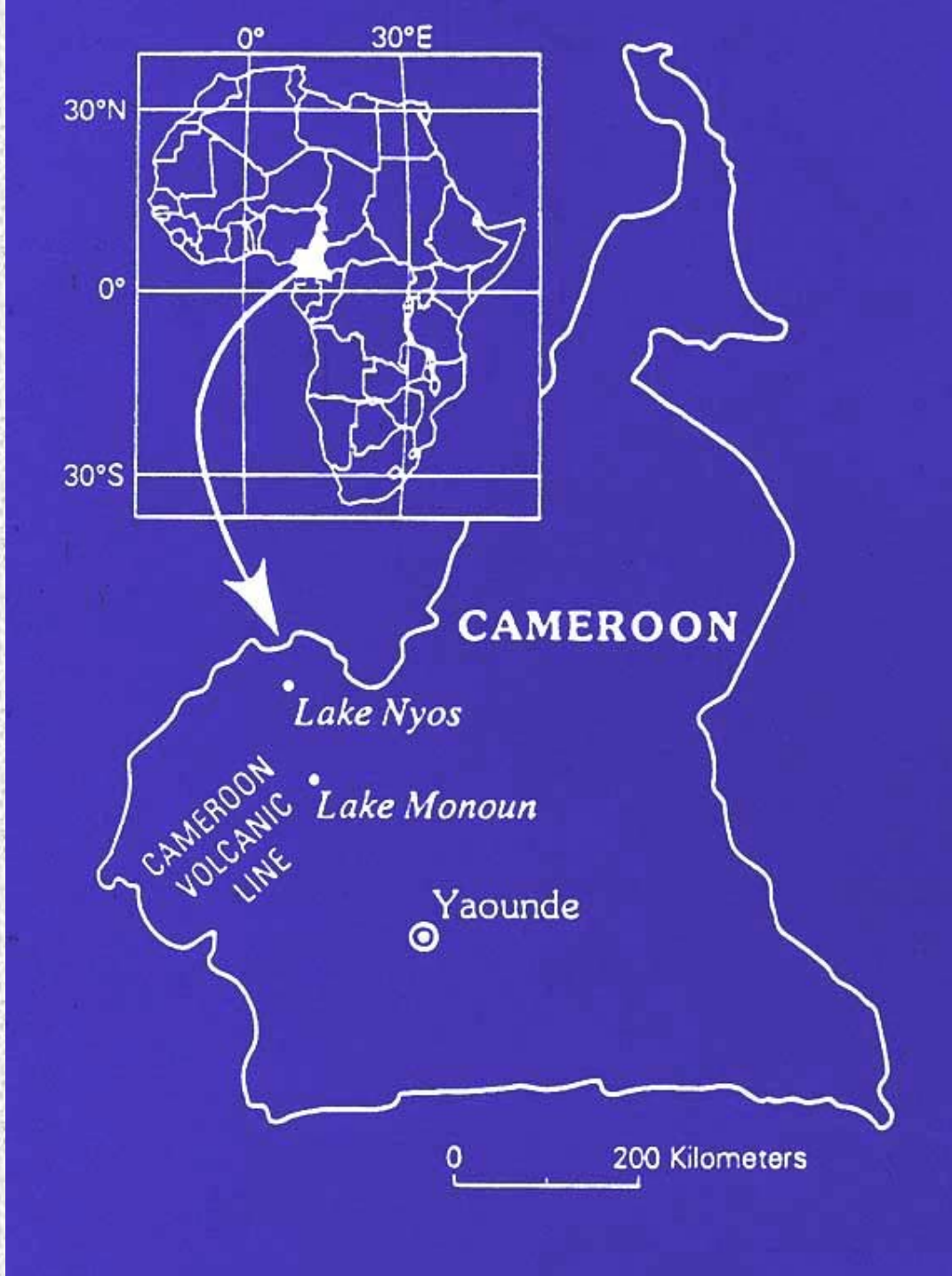
Only 3 lakes in the world are known to have high gas concentrations:

Lakes **Nyos** and **Monoun** in Cameroon, and Lake **Kivu** in East Africa.



On 26 August 1986 an enormous volume of carbon dioxide (CO_2) was released from Lake Nyos that killed about 1700 people. Two years earlier in Lake Monoun a smaller release killed 37 people.

^{14}C, helium and ^{13}C-CO2 data show that the CO2 came from magma (molten rock of volcanic origin)

limnologic hypothesis vs. *volcanic eruption hypothesis*

based on:
- undisturbed sediment
- clear water at depth
- low water temperatures
- absence of acid gases
- low sulfur nature of the system

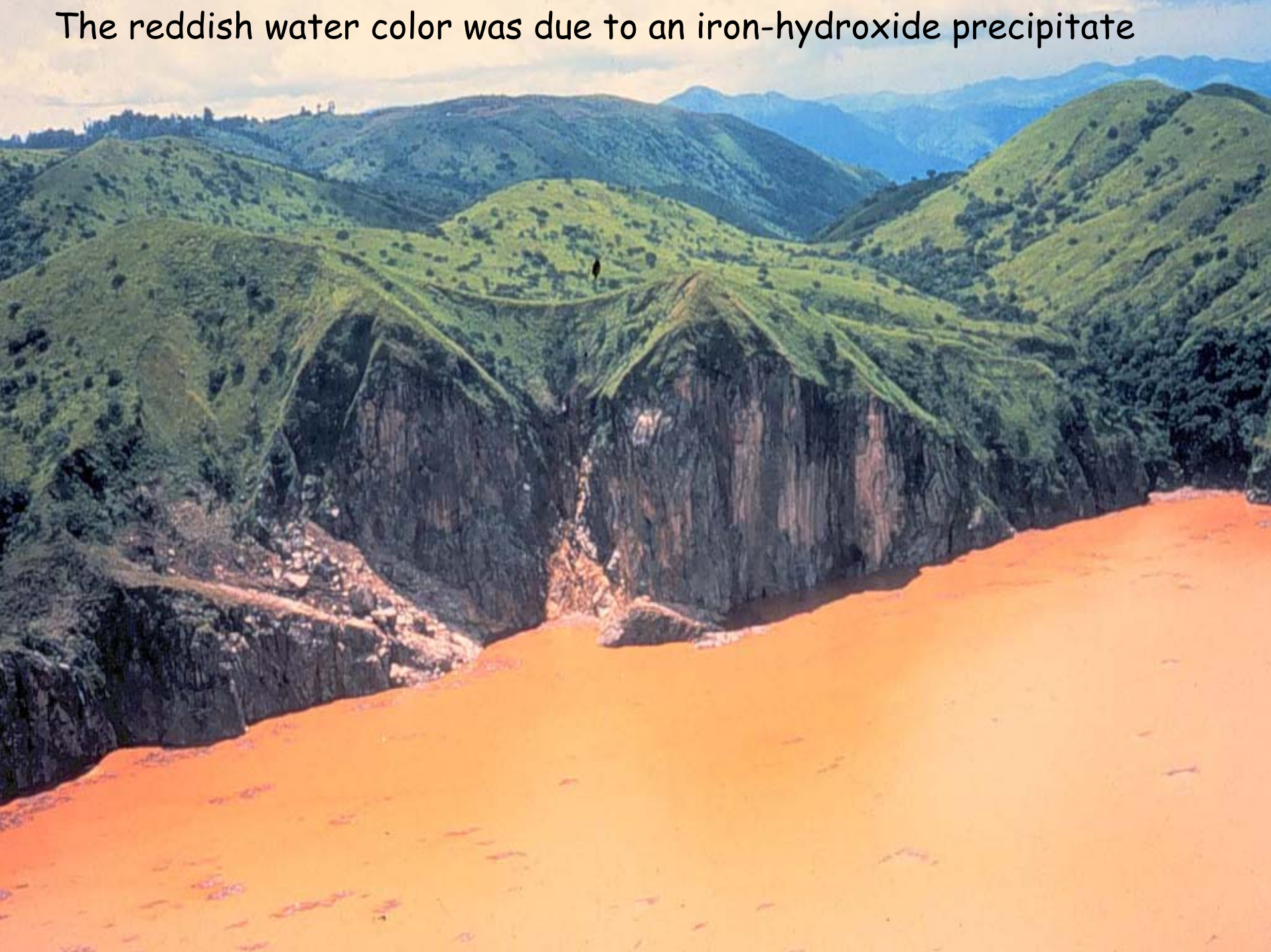
scientist concluded that:

no major volcanic eruption occurred.

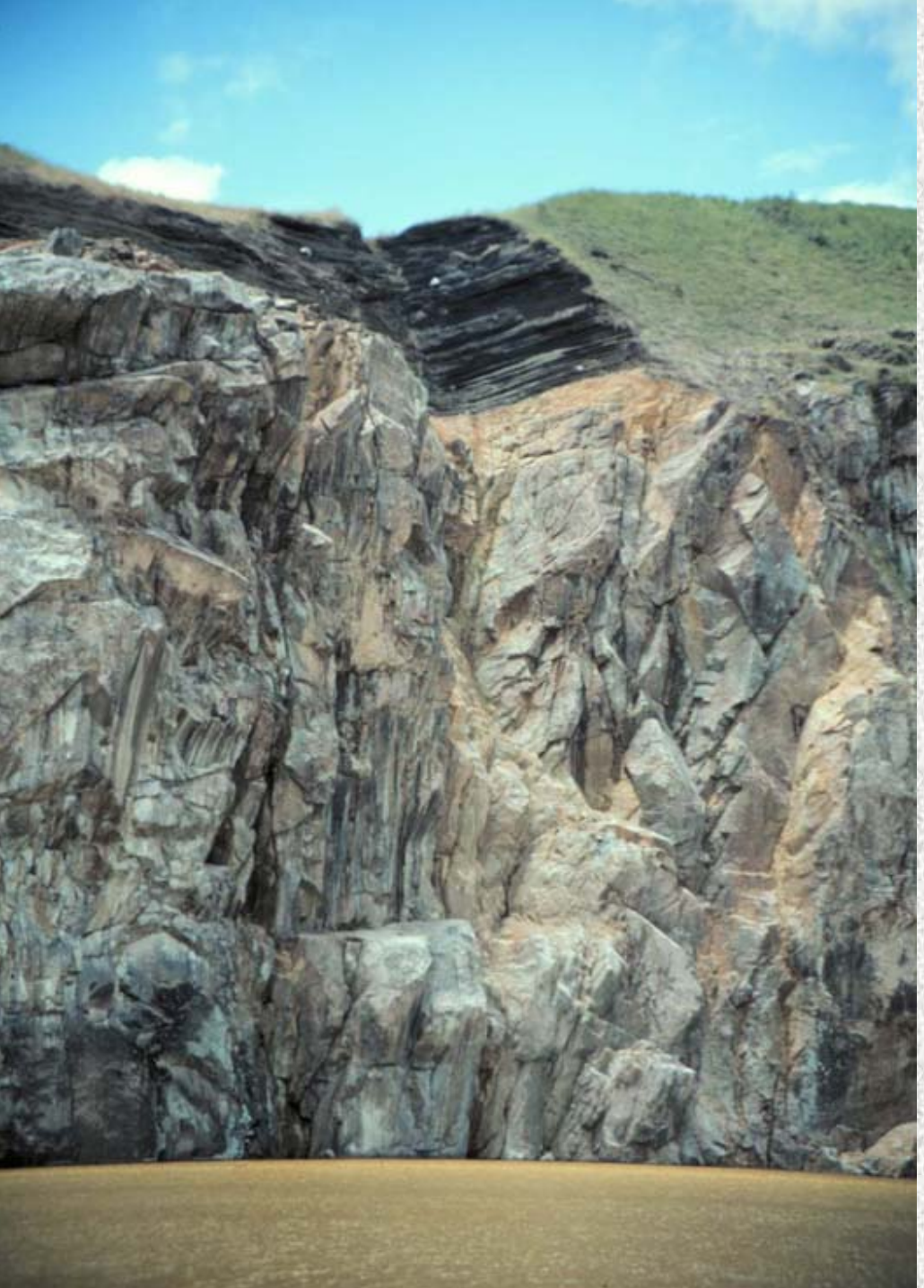

Lake Nyos in May 1985, before the disaster


Lake Nyos ~10 days after the disaster in August 1986

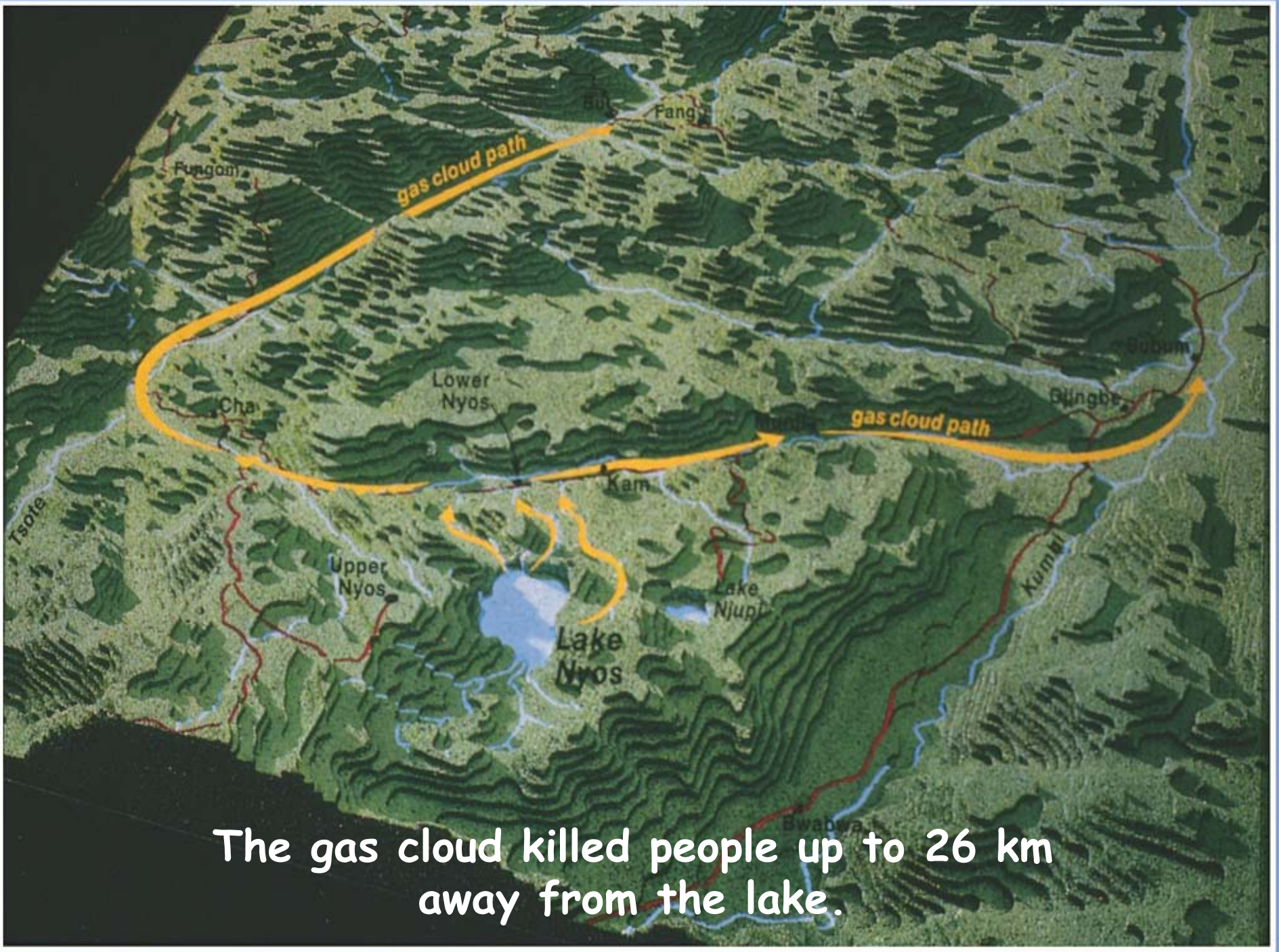
The reddish water color was due to an iron-hydroxide precipitate




Scars along the lake shore suggest a violent release of water and gas.



The gas-water fountain produced by the explosion reached over 80 m in height (and went over the rock promontory shown at left), and produced a surface wave 25 m high.


Fungom
gas cloud path
Lower
Nyos
Cha
gas cloud path
Kam
Tsote
Upper
Nyos
Lake
Njupi
Lake
Nyos
Kumbi
The gas cloud killed people up to 26 km
away from the lake.

Evidence that CO2 caused mortality

Pathological studies indicated that victims rapidly lost consciousness and died of CO2 asphyxiation.

No evidence for chemical burns as would be expected from volcanic S gases

Skin lesions were attributed to:

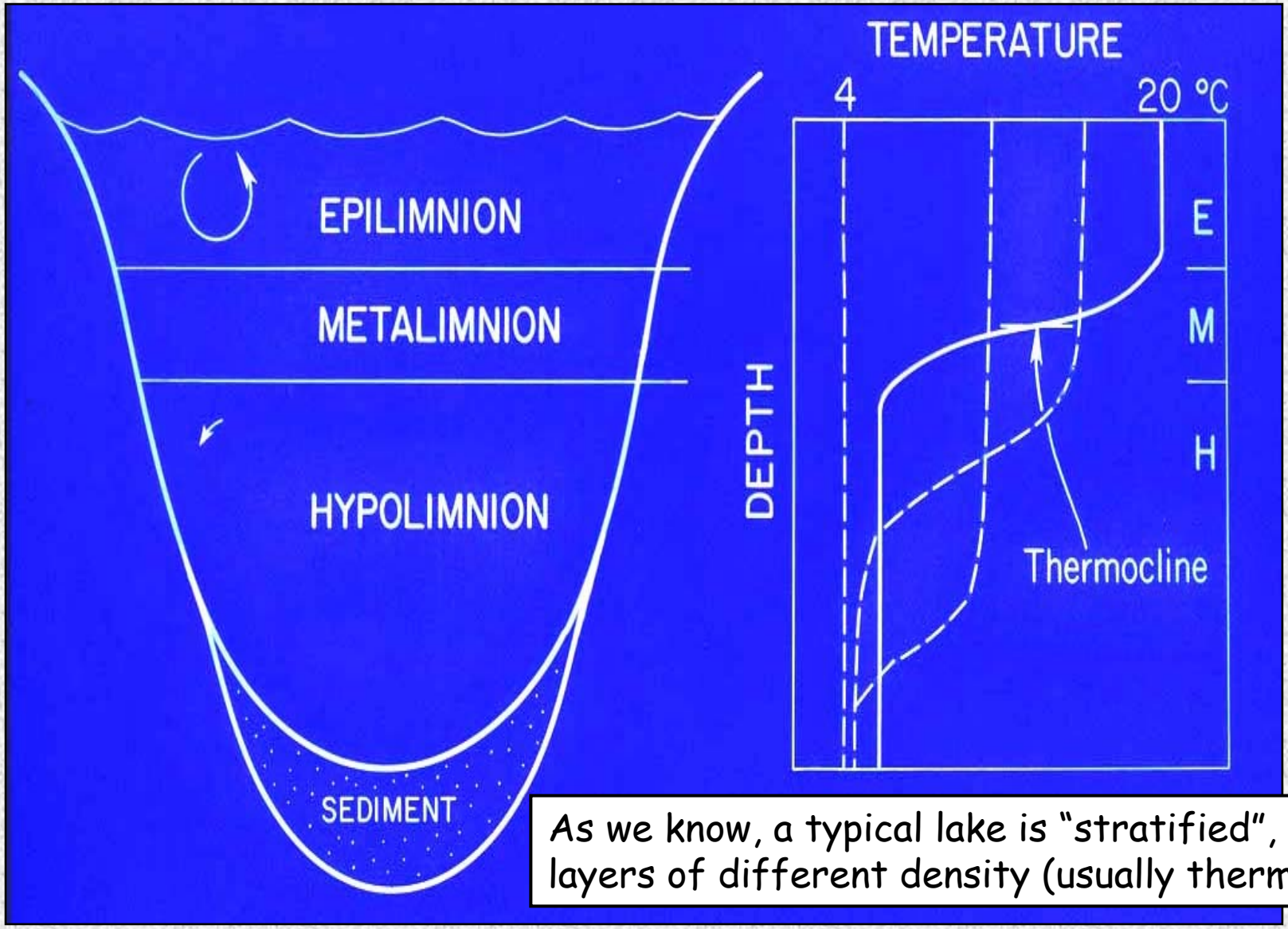
(1) exposure to a direct heat source such as a cooking fire

(2) pressure sores from prolonged lying in a fixed position

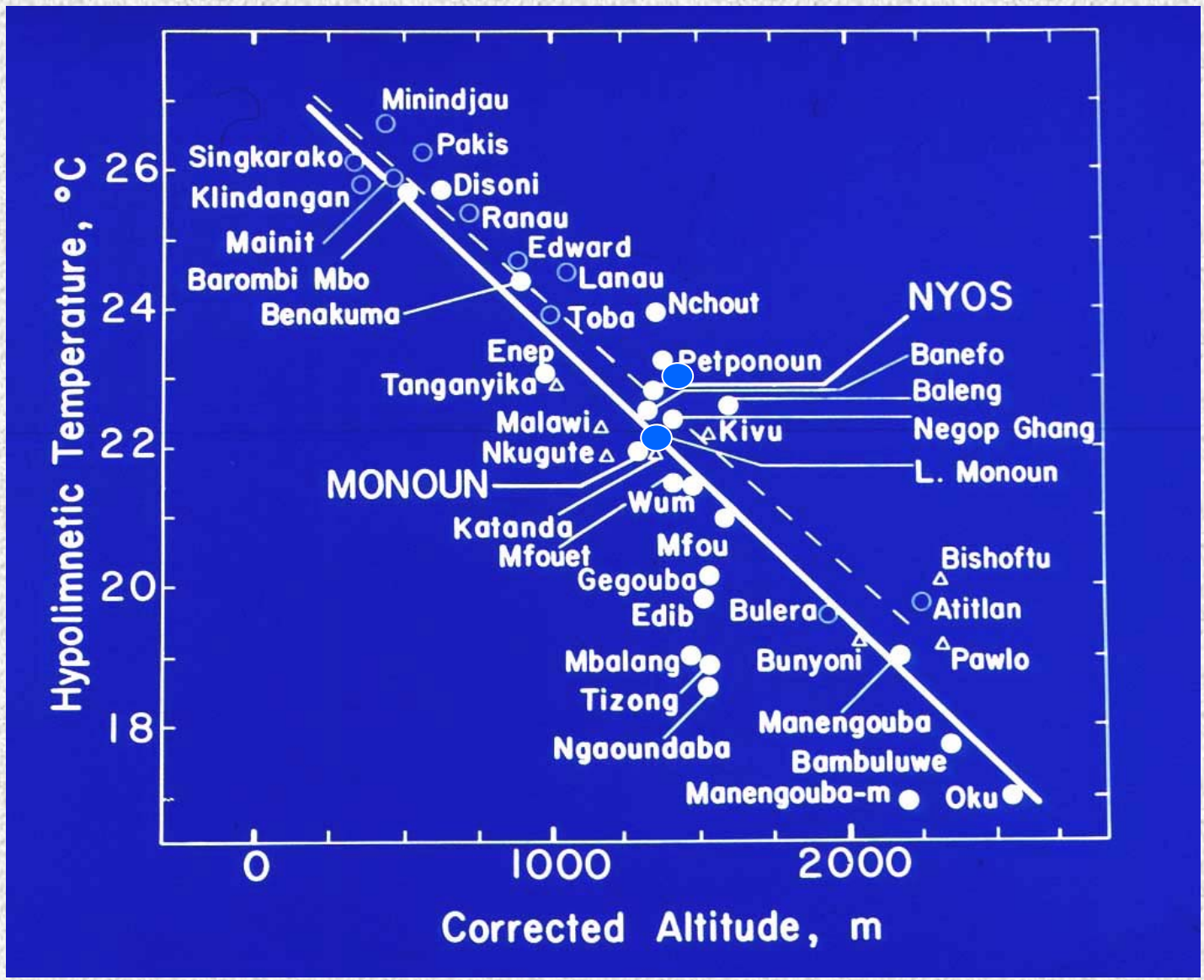
(3) postmortem decomposition

(4) sores that predated the event.

How did the gas emission happen? Role of lake stratification



As we know, a typical lake is "stratified", i.e., has layers of different density (usually thermal)

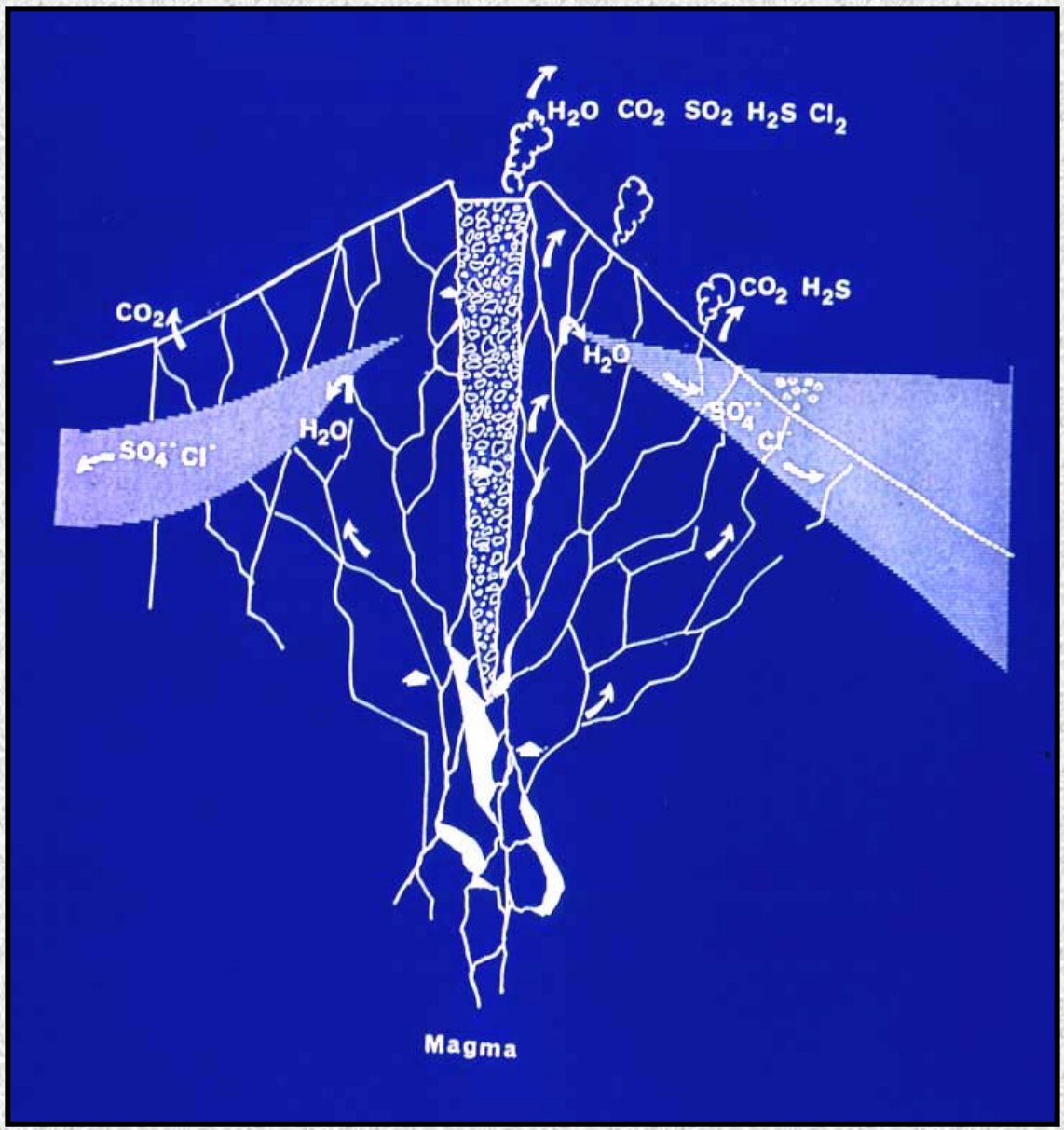


Lakes Nyos and Monoun are high elevation lakes with colder bottom waters. They are more stable as a result (i.e., resist mixing).

Most of the work for mixing of lakes comes from wind.

High crater rims shelter the lakes from the mixing effects of the wind

In combination, these features suggest that the lake's entire volume is rarely mixed (oligomictic)



Where did the gas come from?

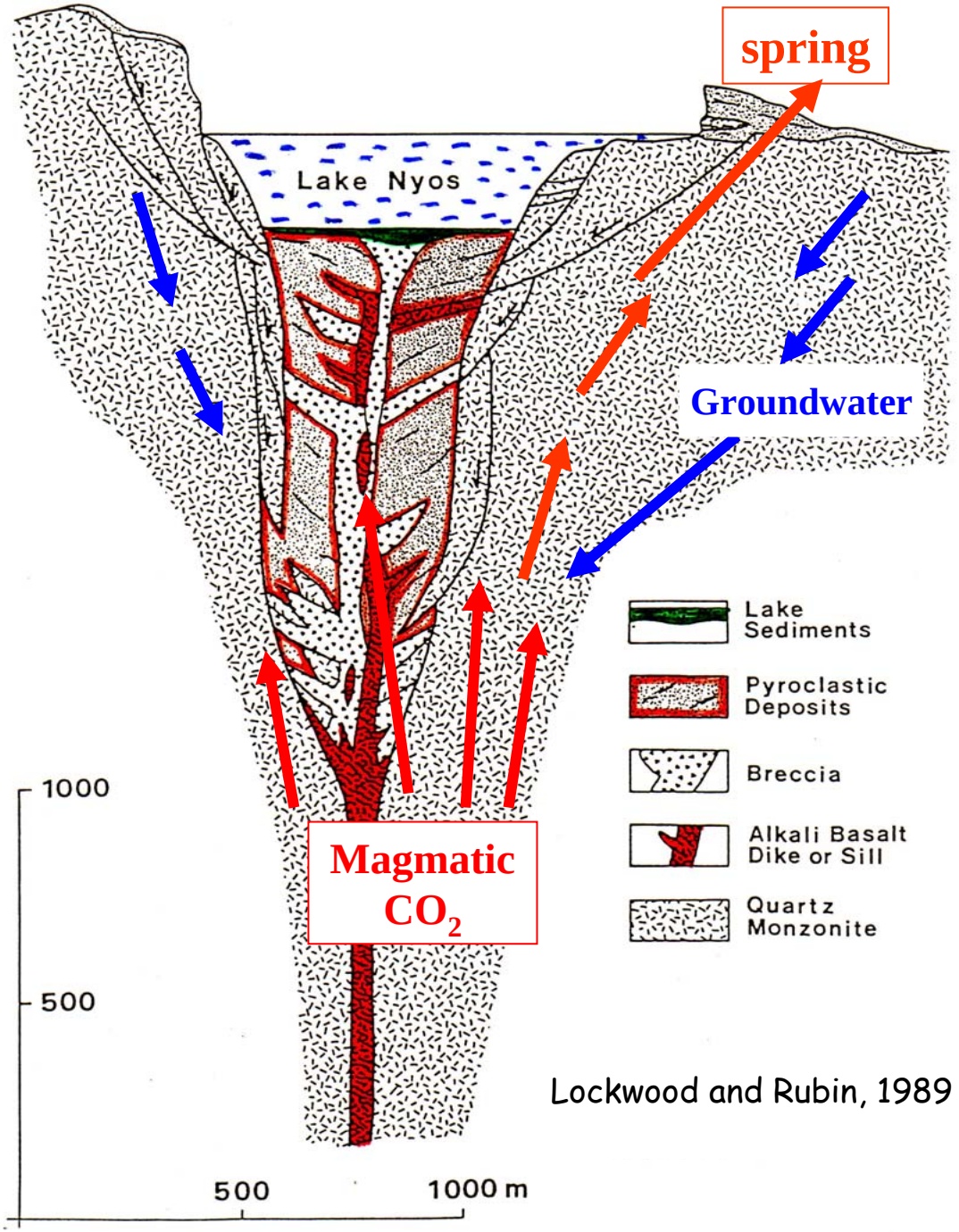
Most volcanoes produce large amounts of toxic gases and heat.

Gases were generated from magma

SOURCE: gases could come from volcanic activity (very hot temps), from biological activity, or from magma

1. Volcanic (hot)
2. Biogenic (from organisms)
3. Magmatic (cool)

- data suggest a magma source



Lockwood and Rubin, 1989

Nearby springs show the connection to CO_2-charged water

STORAGE:

Fissures below the sediment trap gases from magma. Water mixes with the gases.

Chemistry of the springs and lake bottom are very similar.

Groundwater inflow introduces gas-rich water to the bottom of the lake. The pressure of the overlying water column keeps the gas dissolved. The stable nature of the lake keeps the deep water from mixing. If the lake were to mix, then deep water would rise to an elevation where the dissolved gas pressure would be greater than that supplied by the atmosphere and water column.

At that point, the water would de-gas, much like the picture of the soda spring on the next slide.

example of a CO_2-charged soda spring in Cameroon

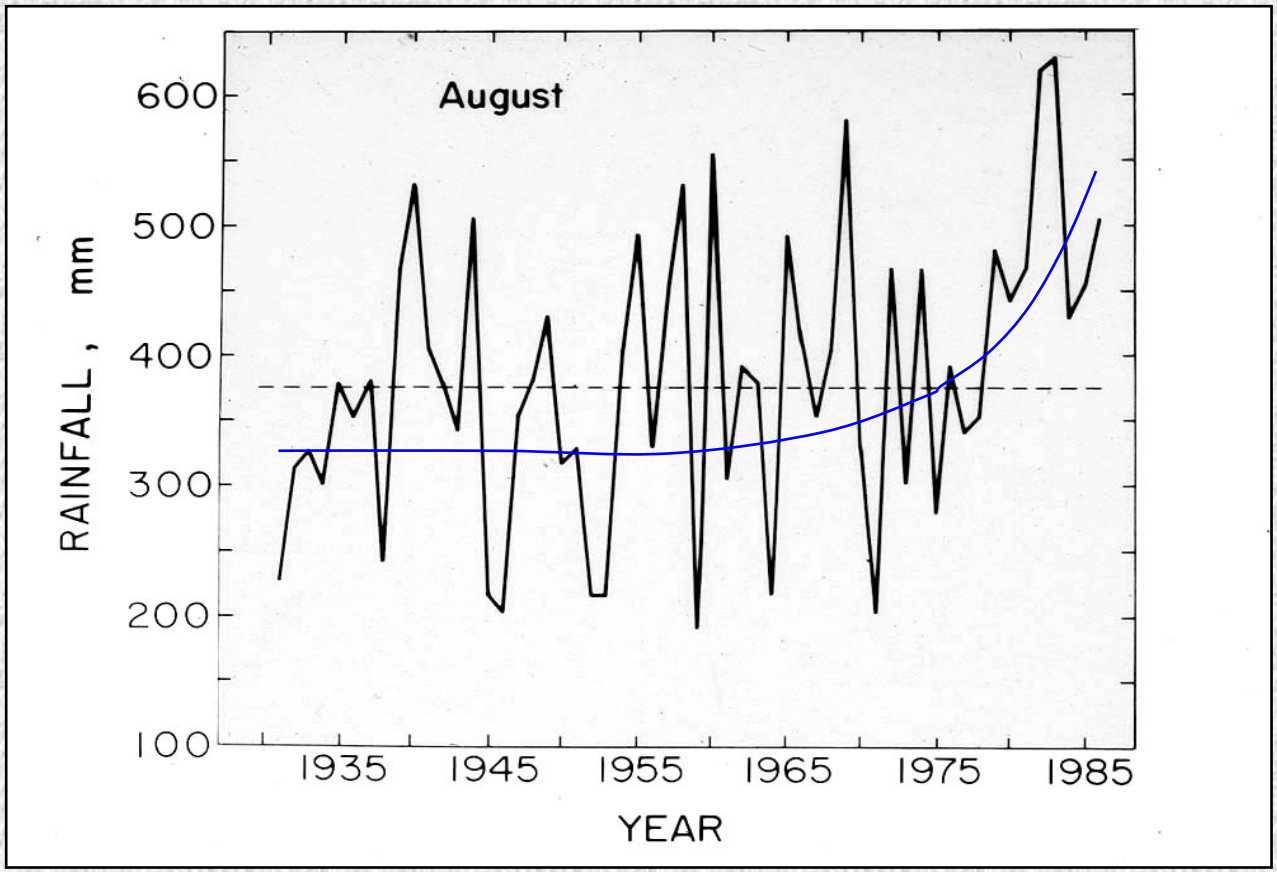
What caused the degassing? Why did it occur in two lakes only two years apart?

The trigger mechanism responsible for the gas release from the lake is unknown but has received much speculation. If the CO2 levels were near saturation prior to the event, almost any physical process common in lakes could have moved water vertically enough to initiate the release. However, it is likely that a large landslide that entered the lake played a role in causing the lake stratification to break down enough to allow local oversaturation to initiate the gas release.

Changing climate probably decreased lake stability

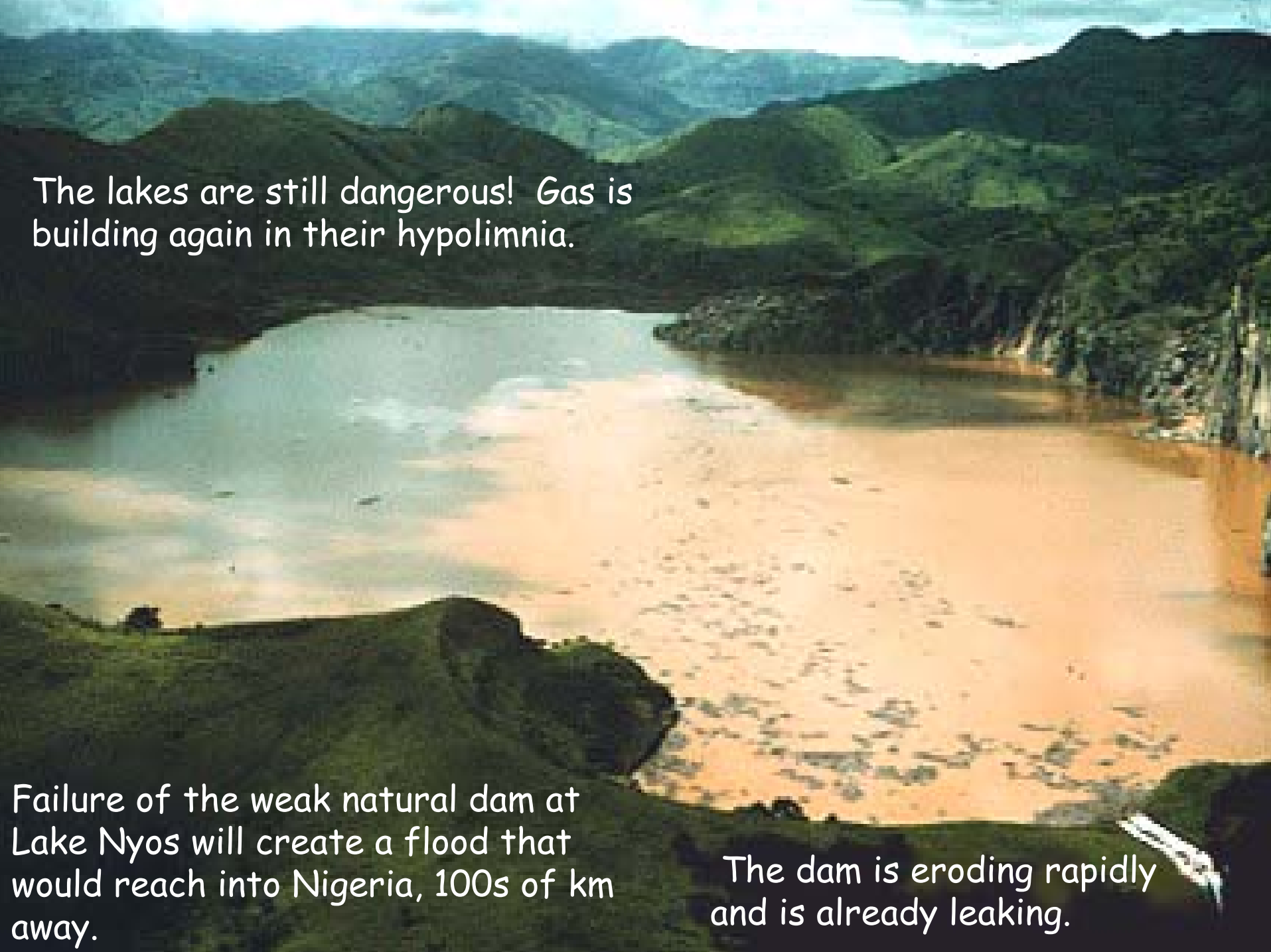
1) cooler temperatures in August

2) increased rainfall



Long-term changes in climate (decreased air temperatures and increased rainfall in August in the middle 1980s) may help to explain the timing of the gas disasters, because conditions would have increased mixing and the potential for a gas release.

Lake Nyos ~1 year after the disaster


The lakes are still dangerous! Gas is building again in their hypolimnia.
Failure of the weak natural dam at Lake Nyos will create a flood that would reach into Nigeria, 100s of km away.
The dam is eroding rapidly and is already leaking.

So, the gases are building up in Lake Nyos and the lake represents a threat to the local populations and to those 100s of km away.

What can and should be done?

What would you propose?